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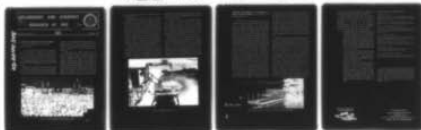
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## RESEARCH AT WES



Miscellaneous Paper 0-73-2



February 1973

### LASER FOR AQUATIC PLANT CONTROL,

by J. G. Collins, *Mobility and Environmental Systems Laboratory*

"If water hyacinths, the creeping green trouble of rivers and courtrooms, are allowed to go unchecked...the results will be disastrous...." This opening statement in a recent article of the Jacksonville, Florida, Times-Union and Journal briefly summarizes the menace posed by the water hyacinth, *Eichhornia crassipes*, a freshwater aquatic plant introduced to the U. S. mainland at the turn of the century.

During the few elapsed decades since its introduction, the hyacinth has spread from coast to coast in the southern states. In a favoring environment the hyacinth will infest a body of water to the extent that it becomes completely

covered by a 2-ft-thick blanket of plant material (fig. 1). Aesthetic appeal is lost; habitat requirements for many desirable fish are destroyed; recreational activities cease; and the navigation of small boats becomes almost impossible.

Existing measures of control include the use of chemical herbicides, biological organisms, mechanical harvesters, and environmental manipulation (drawdown, for example). Although the measures vary markedly in technique, they have two things in common. With the possible exception of biological control, they are expensive in application, ranging from about \$12 to \$1200 per acre (in Louisiana alone, over 6 million acres of water are believed well suited for hyacinth growth). All existing measures are suspected or known to have harmful environmental side effects; therefore, and justifiably or not,

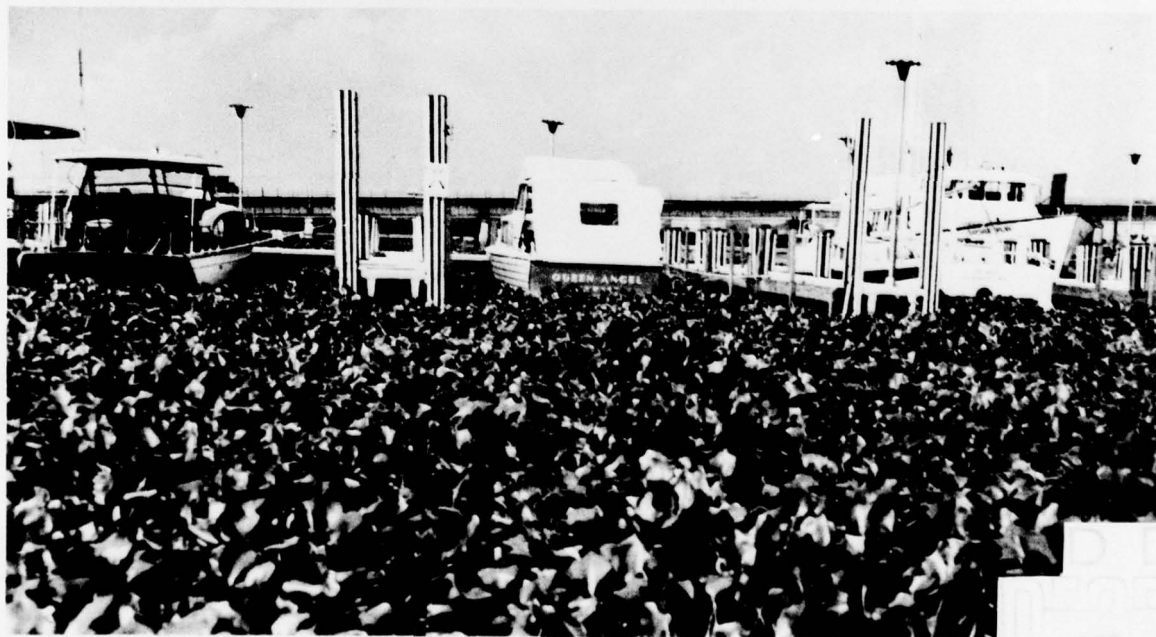


Fig. 1. Water hyacinths, St. Johns River, Florida

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they are becoming more difficult to employ because of formal litigation.

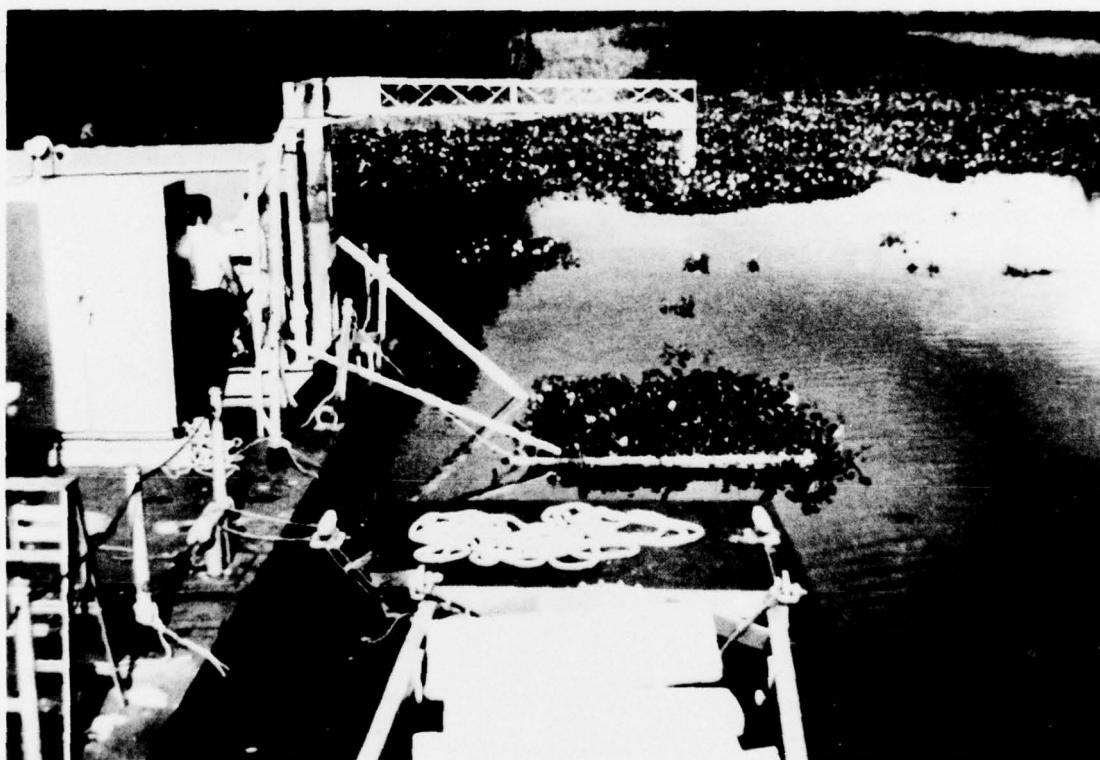
Charged with maintaining the Nation's navigable waterways, the U. S. Army Corps of Engineers has actively participated in aquatic plant control programs for many years. In a search for new and less objectionable measures, research on the feasibility of using lasers was initiated in 1968. Laboratory tests indicated that radiation from a  $\text{CO}_2$  laser (10.6- $\mu\text{m}$  wavelength) would destroy or reduce the growth rate of the water hyacinth through disruption of the plant's metabolic processes. Based on these promising results, the Waterways Experiment Station (WES) was assigned the task of designing, building, and testing an experimental  $\text{CO}_2$  laser system for controlling the growth of the water hyacinth in its natural environment.

Initial investigations by the WES revealed that two general types of gas lasers were in existence: open-cycle in which the lasing gas is exhausted, and closed-cycle in which the gas is recycled. Although both have certain associated advantages, the closed-cycle system was

determined to be more suitable. Following design, a system was built and assembled at the WES. Design output of the system is about 3.5 kw.

In October 1972 the system was mounted on a barge and transported to an area near New Orleans, Louisiana, for preliminary evaluation tests (fig. 2). Although operational problems were encountered, six hyacinth plots were tested with irradiation levels ranging from about 10 to 50 joules/ $\text{cm}^2$ . Follow-up examinations of the irradiated plants revealed significant laser effects, many of the plants being either killed or severely weakened.

Presently the laser is being disassembled and cleaned, and a sweeping mirror system which will allow controlled irradiation is being added in preparation for an expanded and more comprehensive field test program. Quantitative measures of  $\text{CO}_2$  laser effects on growth rates and additional studies of physiological effects are to be conducted and analyzed. Hopefully, future tests will prove that the laser is an environmentally and economically acceptable tool for use in controlling the water hyacinth.



*Fig. 2. WES  $\text{CO}_2$  laser system*

**NATURAL WEATHERING OF CONCRETE AT  
TREAT ISLAND, MAINE,** *by H. T. Thornton, Jr.,  
Concrete Laboratory*

The ultimate test of the durability of concrete is its performance under the exposure conditions in which it is to serve. Although laboratory tests yield valuable indications of probable durability, the potential disrupting influences in nature are so numerous and variable that actual field exposures are highly desirable to assess the durability of concrete exposed to natural weathering. To this end, the Corps of Engineers, through the Waterways Experiment Station Concrete Laboratory, maintains a natural weathering exposure station. The station is located at Treat Island in Cobscook Bay near Eastport, Maine. This station has been in use since 1936 and is an ideal location for these tests, providing twice-daily tide reversals, together with severe winters. The specimens are installed at mean-tide elevation and the alternate conditions of immersion of the specimens in sea water, then exposure to cold air, provide numerous cycles of freezing and thawing of the concrete during the winter. The effect of the relatively cool summers is to lessen, in general, autogenous healing and chemical reactions in the concrete. The tidal range is a mean of about 18 feet, with a maximum of about 28 ft and a minimum of about 13 ft. Most of the specimens are installed on a mean-tide exposure rack; the rest are on the beach at the mean-tide elevation.

In winter, the combination of air and water temperatures creates a condition in which specimens at the mean-tide elevation are thawed to a temperature of about

37 F when covered with water, and are frozen to temperatures as low as -10 F when exposed in air. A recording thermometer, the bulb of which is embedded in the center of a concrete specimen, records these temperatures. A cycle of freezing and thawing consists of the reduction of the temperature at the center of a concrete specimen to below 28 F, and its subsequent rise to above that figure. During an average winter, the specimens are subjected to over 100 cycles of freezing and thawing. In 12 winters, from 1960 to 1972, the number of annual cycles has ranged from 89 to 185, with the average being 145.

Through the years, some 1500 specimens have been installed at the Treat Island exposure station. Although most of the specimens exposed are of concrete, other materials such as nonmetallic waterstop, woven plastic, and plastic-based mortar coatings have been investigated. Specimen sizes include 3-1/2- by 4-1/2- by 16-in. beams, 6- by 6- by 30-in. prisms, 18- by 18- by 36-in. prisms, 2-ft cubes, and 10- by 16- by 96-in. prestressed beams loaded flexurally. The fact that very large specimens can be accommodated makes the exposure station an excellent facility for testing mass concrete mixtures at a very economical cost. Each specimen is visually inspected each week during the freezing-and-thawing cycling period; and each year after freezing and thawing have ceased, a technical inspection is performed using the resonant frequency and pulse velocity nondestructive testing techniques. Specimens are regarded as having failed when they separate into pieces, when the modulus of elasticity is 50 percent or less, or when deterioration has progressed



*Field exposure station for concrete specimens at Treat Island, Maine*

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TIME		X	
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to a point that reliable determinations of fundamental frequency or pulse velocity cannot be obtained.

Extensive studies have been made in an effort to compare performance of concrete in service in structures, performance of test specimens at Treat Island, and performance of specimens in the laboratory freezing-and-thawing test. No basis for quantitative correlation has been found. However, several useful general relations are known. These are summarized below:

- a. Nonair-entrained concrete that becomes critically saturated with water will be destroyed by freezing and thawing in service, at Treat Island, or in the laboratory. At Treat Island such destruction generally takes place in the first winter. In the laboratory it generally occurs in fewer than 50 cycles of freezing and thawing. Where nonair-entrained concrete survives more than one winter under saturating conditions in service, it may be concluded that saturation did not become effective.
- b. Air-entrained concrete will be essentially immune to frost action, even though critically saturated, if (1) the aggregates are sound, and (2) the concrete has matured to a degree sufficient to develop a strength of about 4000 psi before being saturated and frozen.
- c. Degrees of unsoundness of aggregates used in air-entrained concrete exposed after appropriate maturity are reflected in relative degrees of durability in service, at Treat Island, and in the laboratory. Aggregates from different sources, having different properties, used in similar air-entrained concrete mixtures will be associated with different durabilities but the ratings will usually be similar in the field and the laboratory except as there is a particle size or specimen size effect.

#### REPORTS RECENTLY PUBLISHED BY WES

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*Engineering and Scientific Research at WES* is published by the Waterways Experiment Station (WES), Vicksburg, Mississippi, to acquaint U. S. Government agencies and the research community in general with the many-faceted types of engineering and scientific activities currently being conducted at WES. Inquiries with regard to any of the reported specific subjects will be welcomed, and should be addressed to respective authors, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Mississippi 39180.

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